Re-examining Helium Retention Experiments and Redesign of FLIRE

P.W. Brenner, D.N. Ruzic, B.J. Schultz,
R. Stubbers

Plasma Material Interaction Group
University of Illinois at Urbana-Champaign

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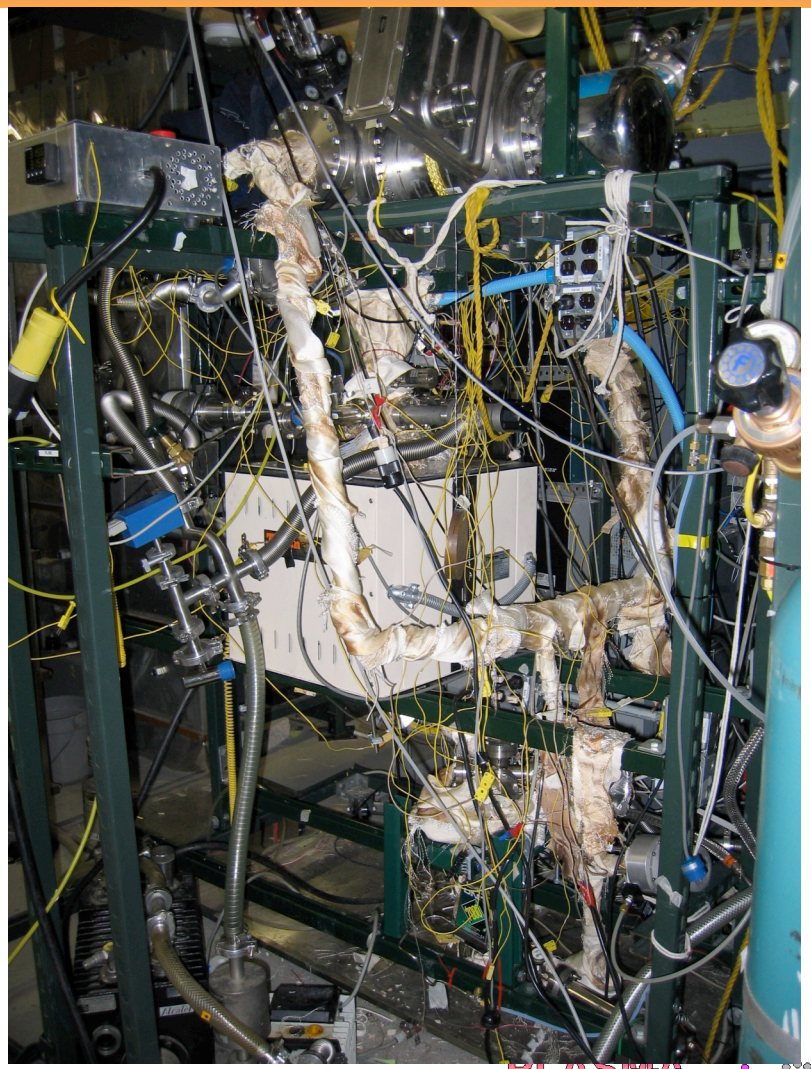
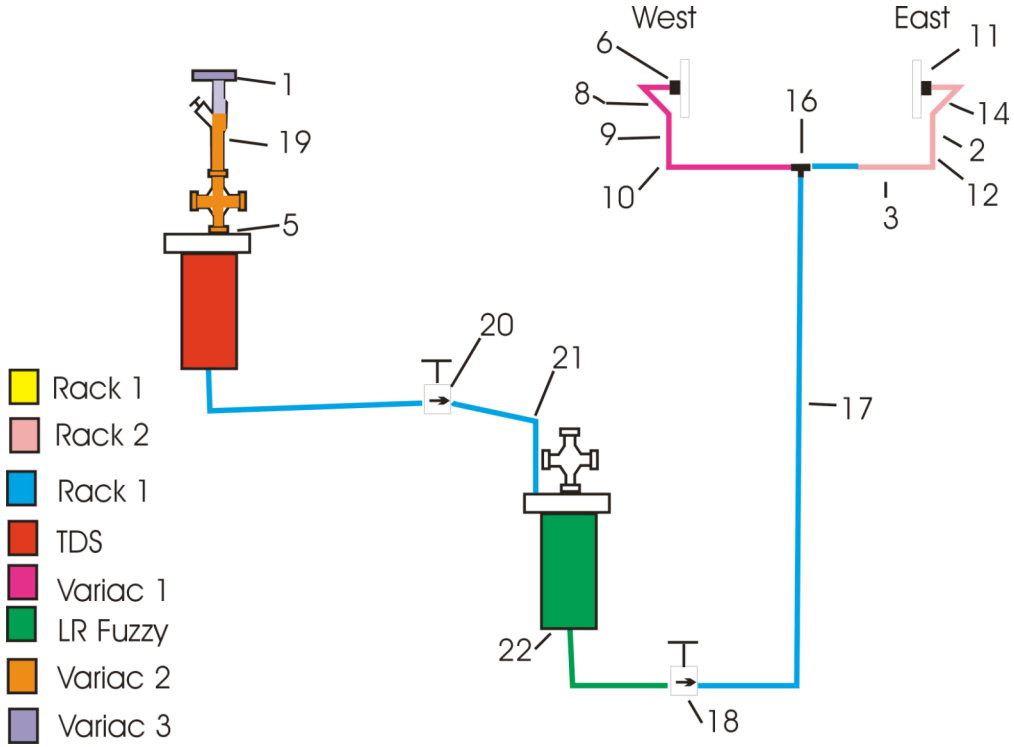
Overview

- Redesign of FLIRE
- Previous Results on He Retention
- Changes made to re-examine data
- Current results on He retention
- Future work on FLIRE



FLIRE has been redesigned

- Troubles in previous designs include cold spots and clogs
- New design focuses on reducing Li path length
- Remaining components include upper chamber, TDS, lower chamber, and Li transfer lines
- Viewports have been added to see flow from upper chamber to TDS
- All metal valve has been added between upper chamber and TDS
- Shutter has been added to protect ramp from ion beam



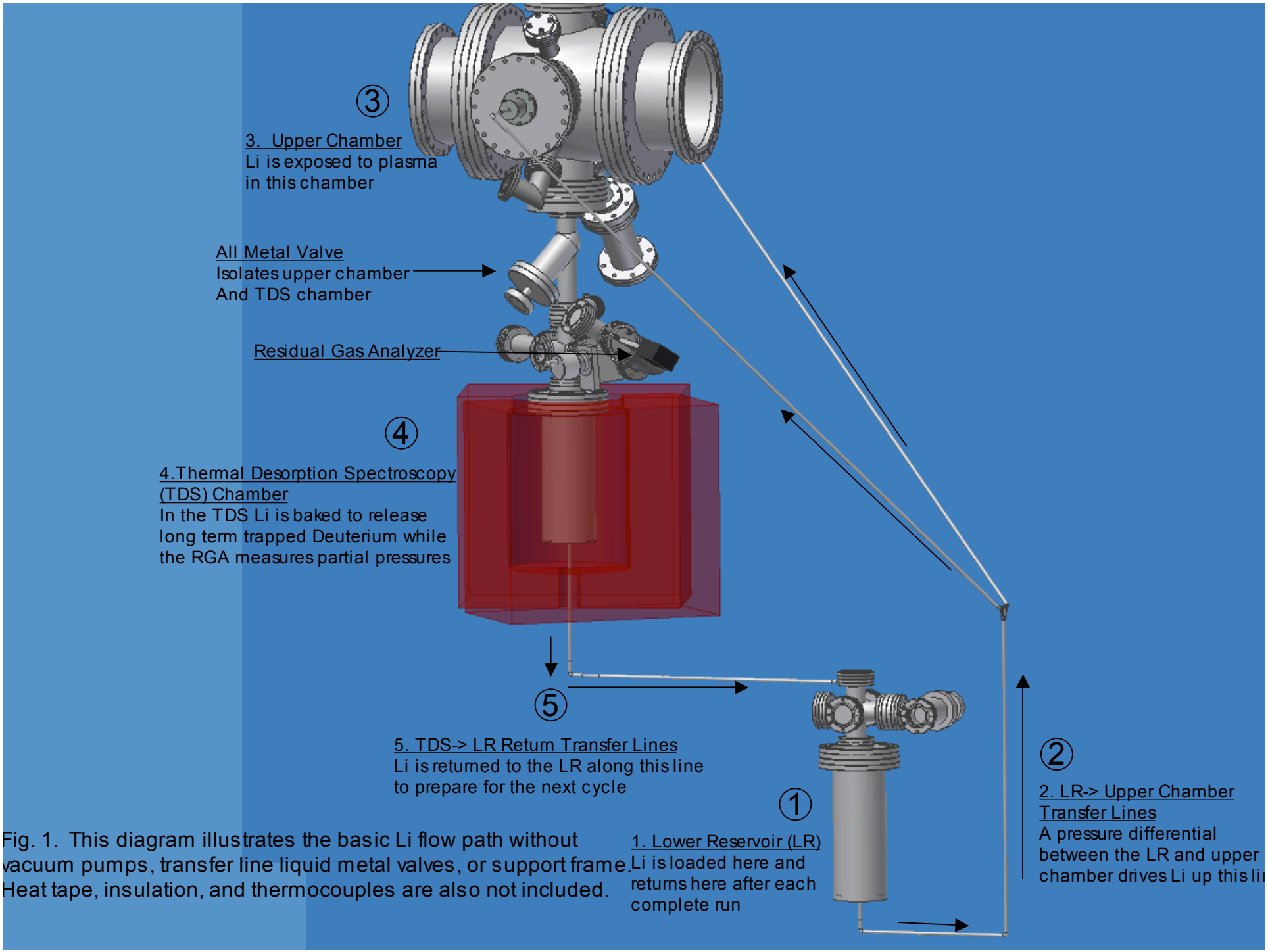
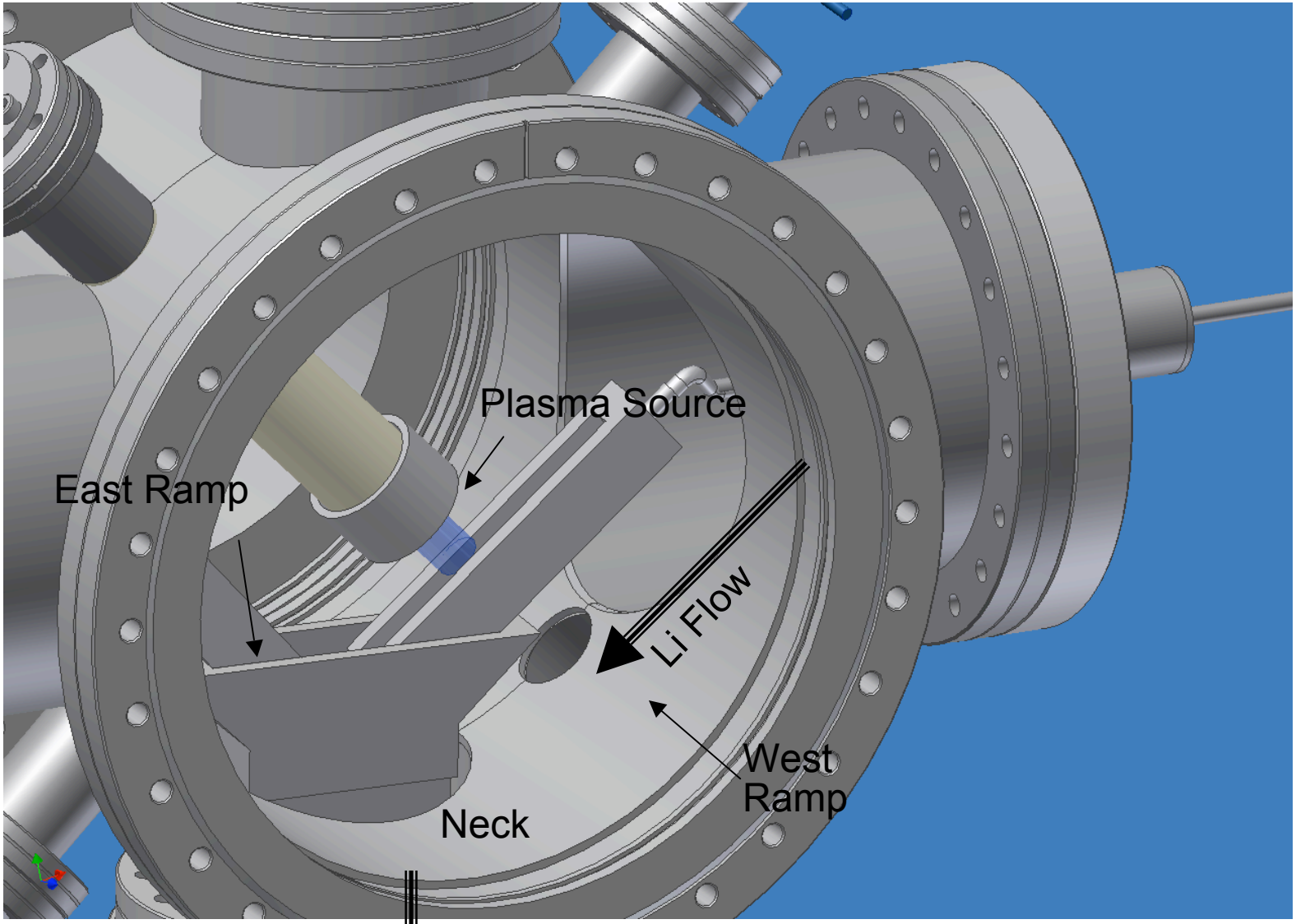
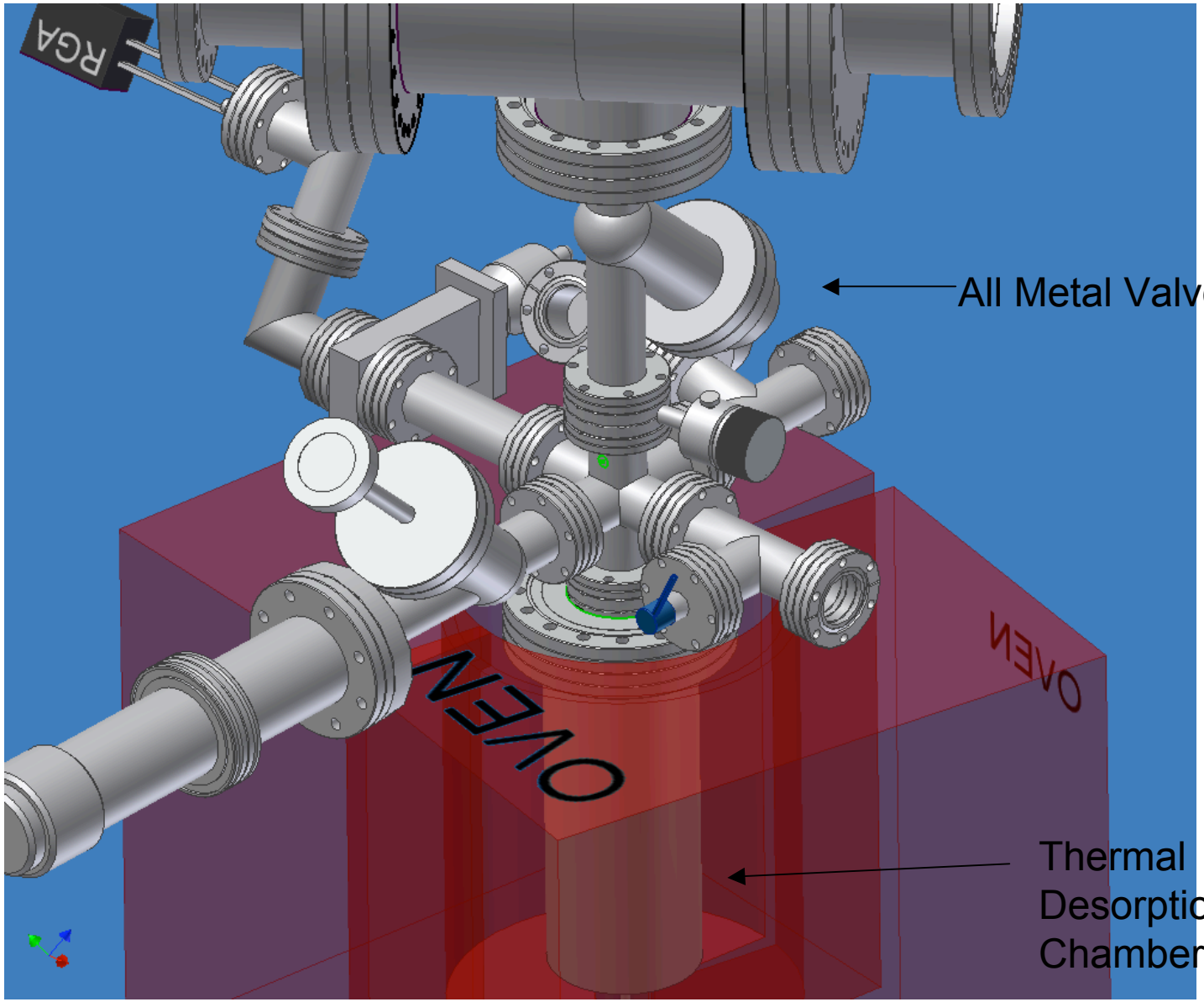


Fig. 1. This diagram illustrates the basic Li flow path without vacuum pumps, transfer line liquid metal valves, or support frame. Heat tape, insulation, and thermocouples are also not included.



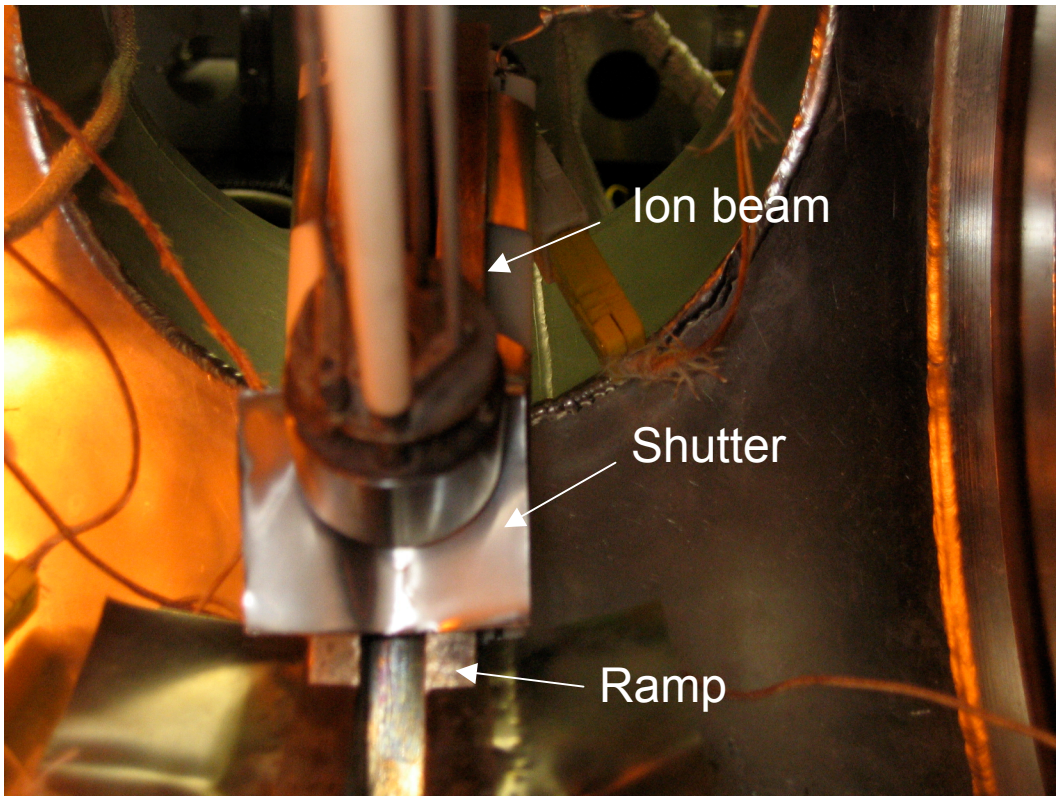
Lithium flows into the upper chamber through a ¼" tube feed-through. The lithium then flows down the ramp where it is exposed to the plasma. After exposure the west flow meets the east flow in the neck where they fold into each other, trapping any retained Deuterium until the lithium exits the neck into the Thermal Desorption Spectroscopy (TDS) chamber.



The thermal desorption chamber sits in an oven below the upper chamber. After exposure lithium can flow through the open valve straight into the desorption chamber for baking. While the Lithium bakes, The upper chamber is isolated by an all-metal valve having a nickel bonnet.

A shutter has been added to protect the ramp from the ion beam

- Previous experiments have not taken He implantation on steel ramp into consideration
- A shutter has been added to protect the ramp
- Shutter can be opened once Li flow starts and closed before flow ends



The focus of experiments has been to reconfirm He measurements

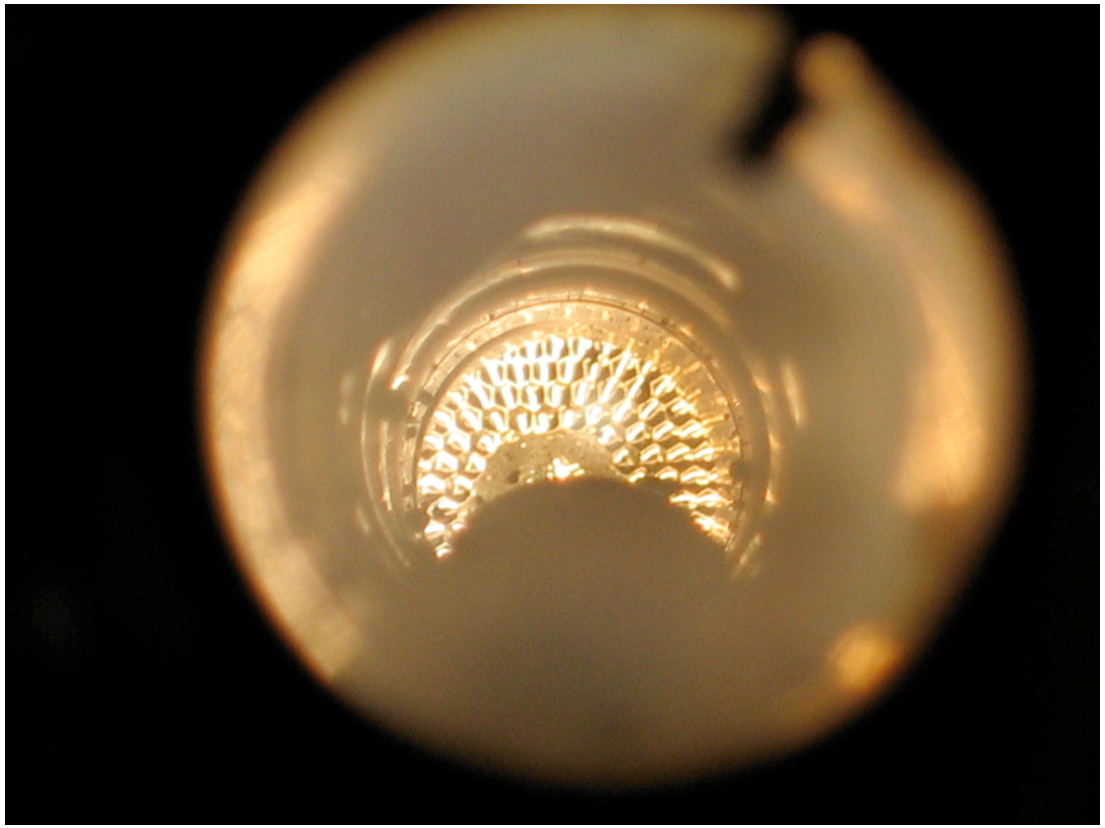
- Specific Tests Examined
  - Ion Gun Shutter (IGS) closed during flow
  - IGS only open during flow
  - IGS open before flow to inject D into ramp and closed as soon as flow begins

Previous Results – High Retention

- Could have been due to release of implanted D in bottom of SS ramp during the flow
- Could have been due to Li traveling as droplets or a film on the wall of the lower chamber – therefore releasing trapped He very quickly
- Could be due to as of yet unknown mechanism – which could also be present in a fusion device!

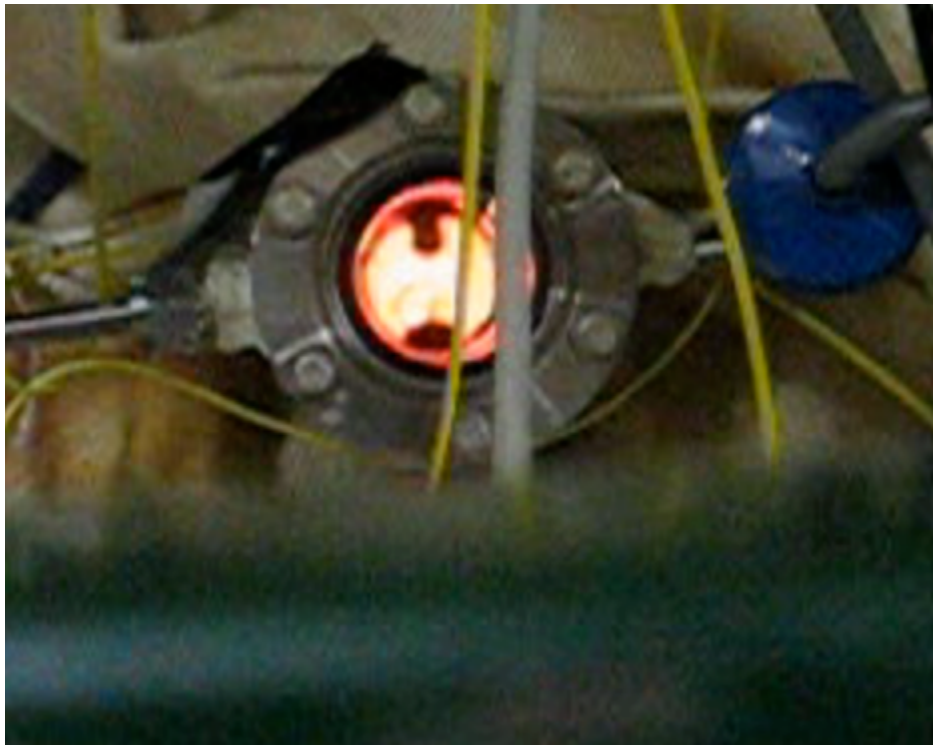
Flow between upper chamber and TDS can now be viewed

- Viewports allow access to view Li Flow and Li buildup in mid area
- Flow has been seen to be droplets initially and then flowing down the walls as Li built up in the chamber wetted the walls.

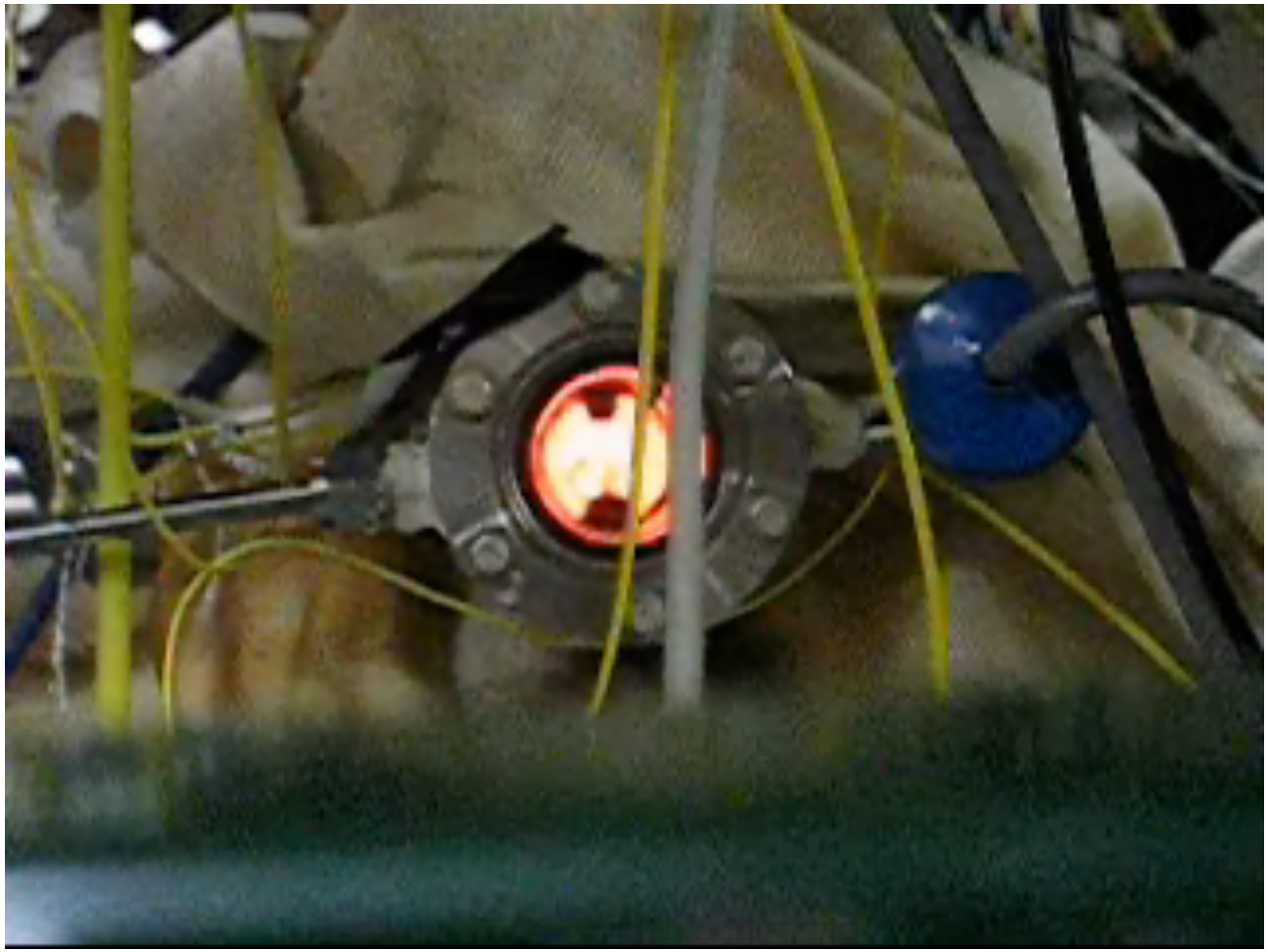


Droplet Flow

- Initial run with fresh Li and clean chamber showed droplet flow from upper chamber to TDS

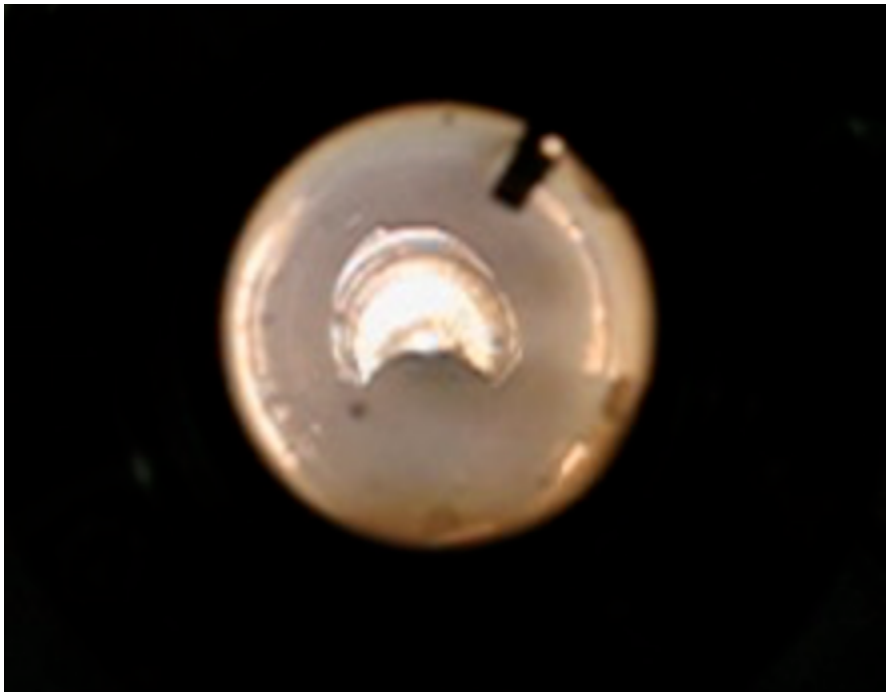


Droplet Flow Video

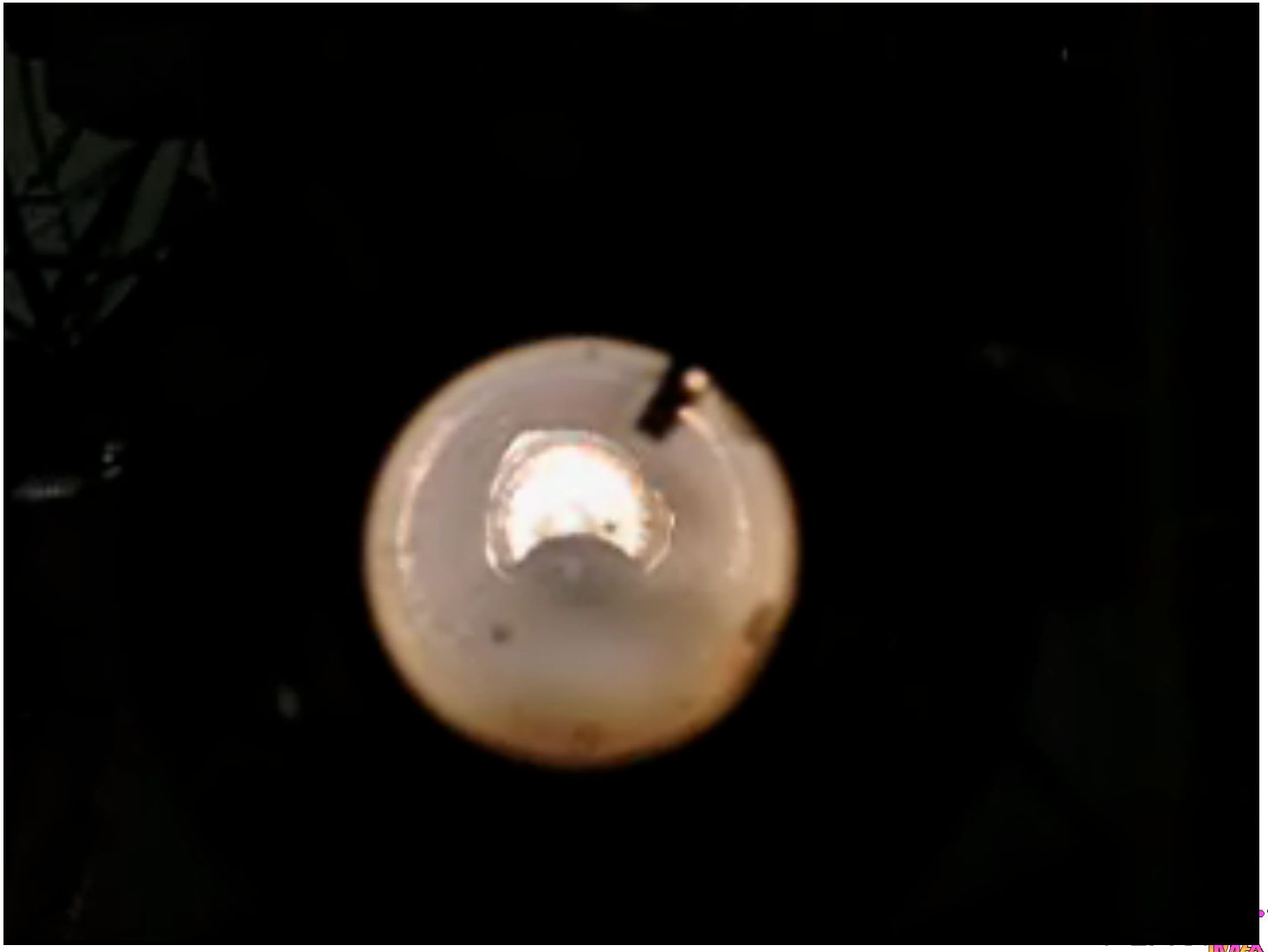


Wall Flow

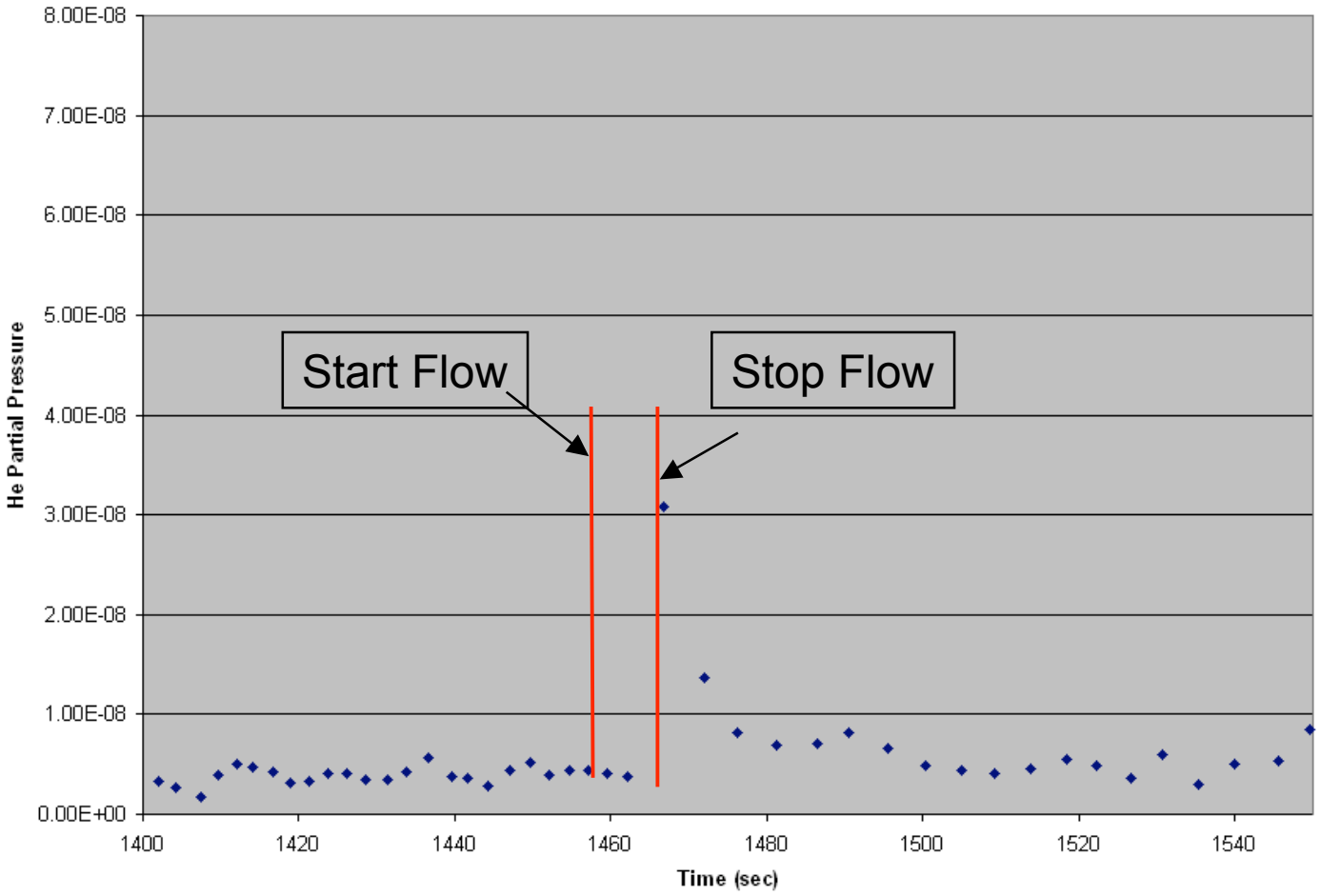
- After a Li fountain event which wetted all the walls, the flow was seen going down the walls as a film



Wall Flow Video



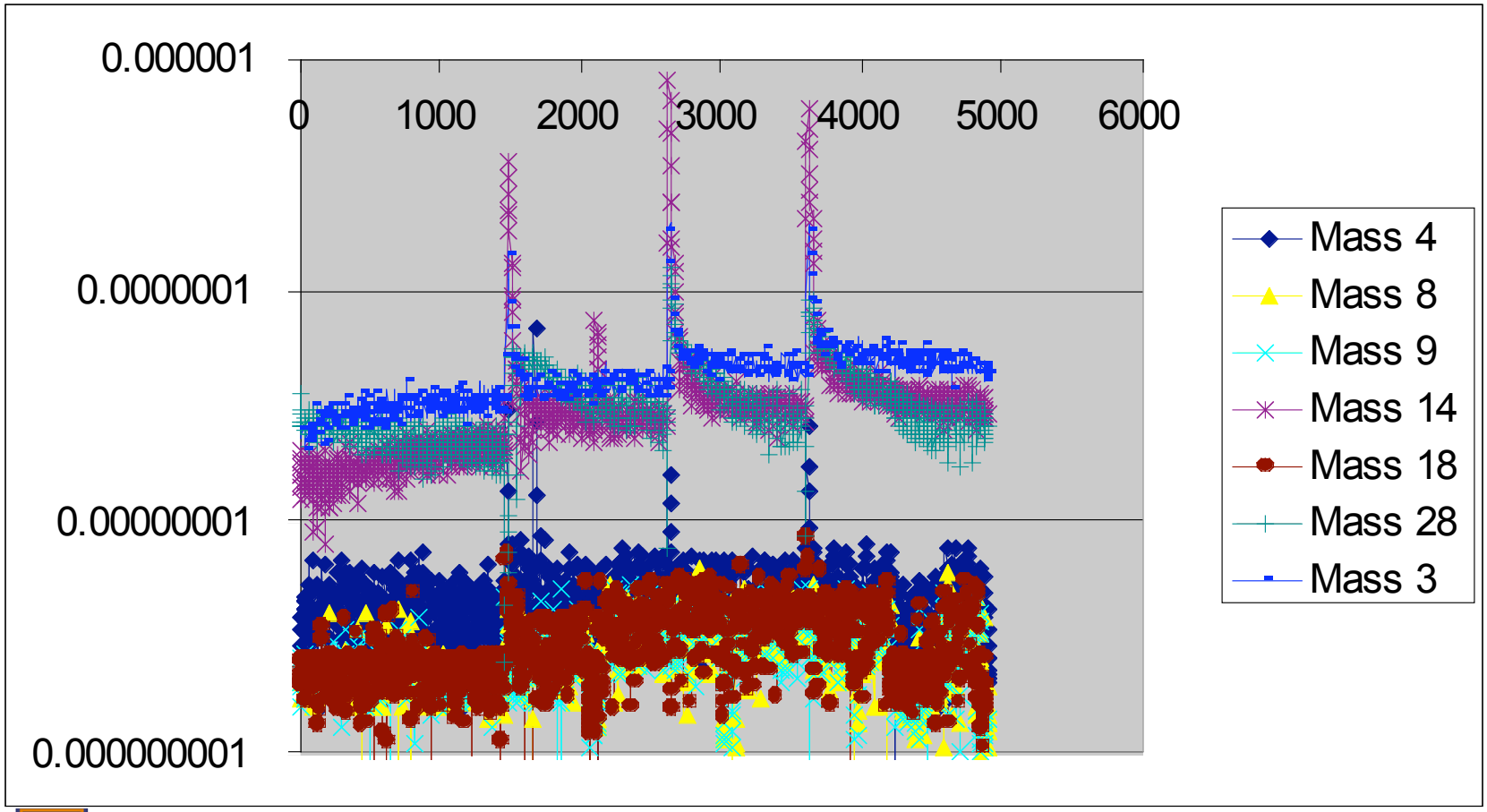
Shutter Closed (Ion Gun On)



He signal seen when flow stops

Vacuum isolation momentarily breeched

Same signal seen in all ion species

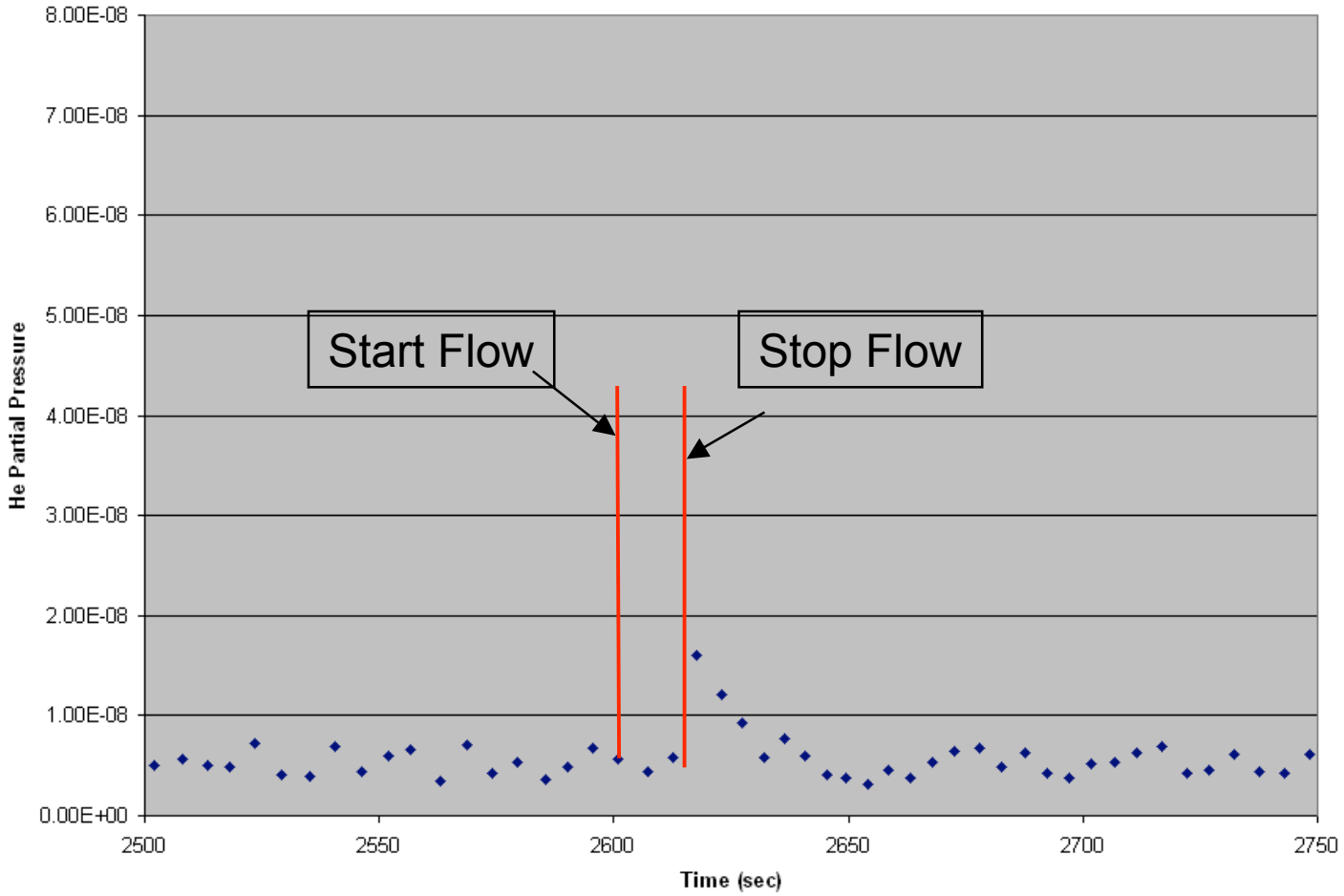


Why is this seen now ?

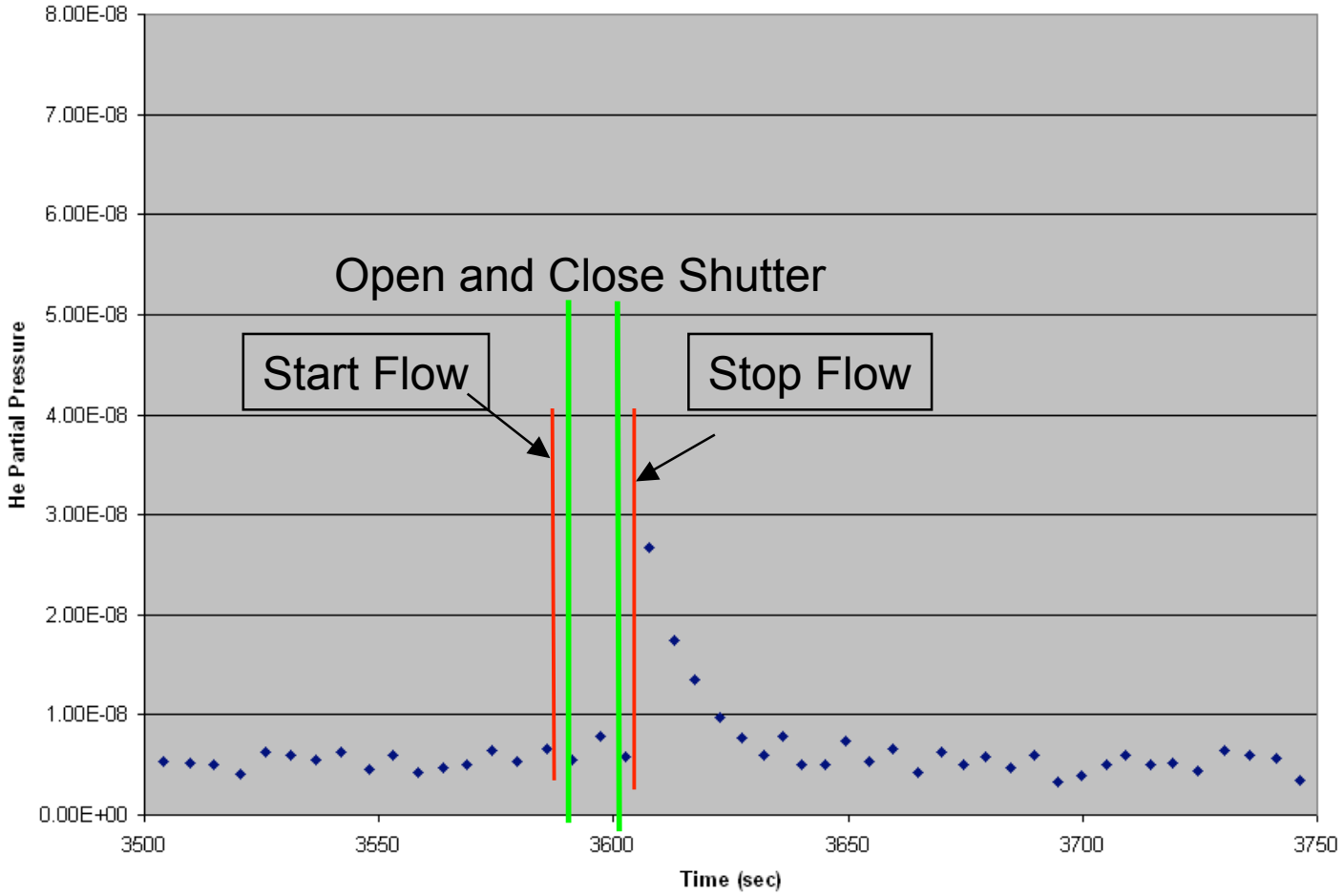
- Lower walls extremely wetted
- Ramp temperature is at 400 C due to heater failure on second ramp

- Under these conditions, momentum of flow likely opens a channel for a moment before meniscus forms re-establishing vacuum isolation
- However, this is at the end of the flow....

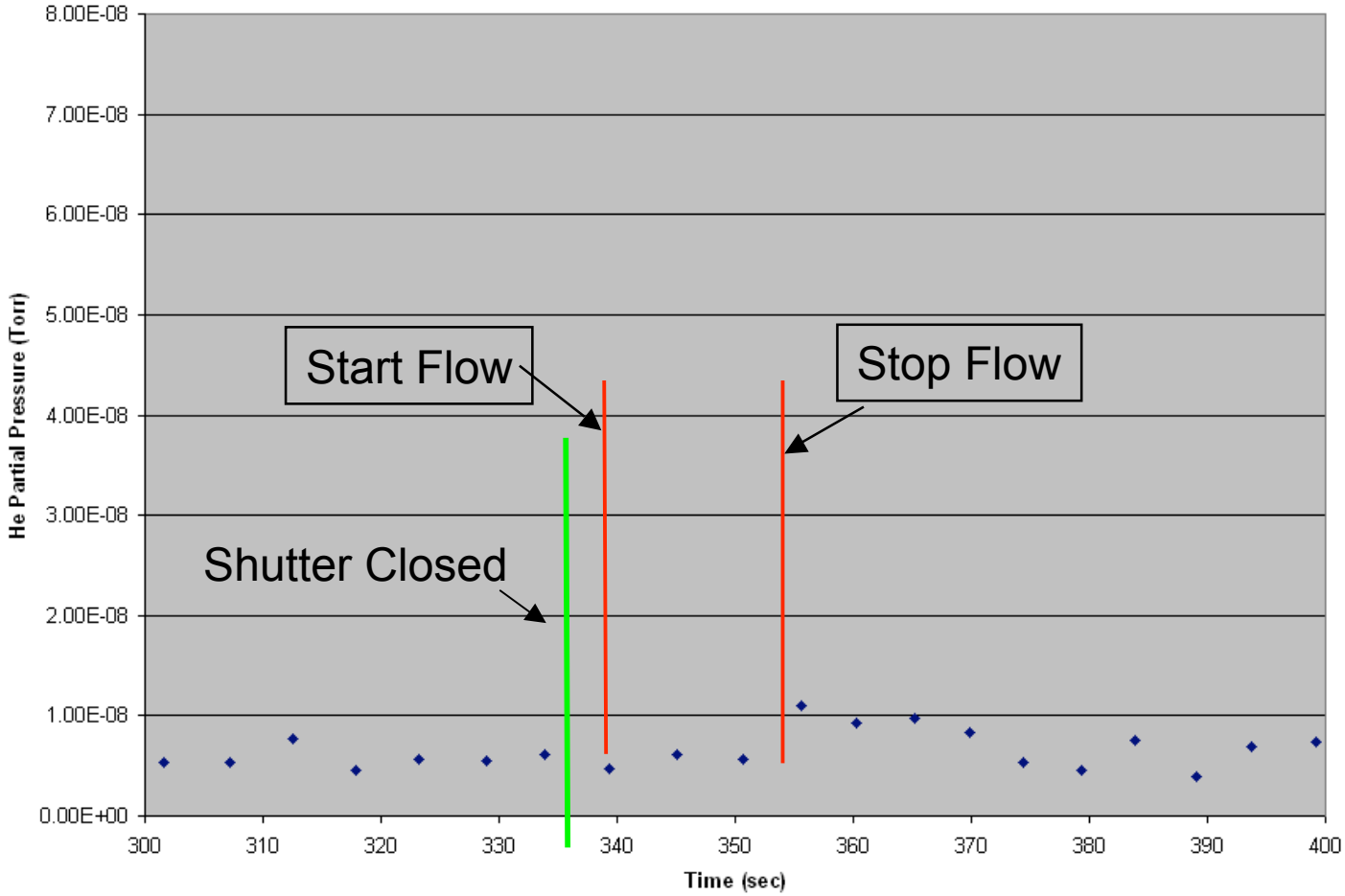
Same as last time: Ion gun on, Shutter closed whole time



Gun on, Shutter opened and closed during flow



Ion gun on ramp for five minutes, then shutter closed and flow started



Conclusions

- Runs to this date have been inconclusive
- Need to repeat with
  - Ramp temperature same as Li (230 C)
  - Higher time resolution on RGA
  - Longer Li flow times
  - Clean lower chamber to eliminate film flow and momentary chamber equilibration